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Process of Growth in a Dualistic Economy:
The Interaction of Population Growth
and Technological Improvements in Agriculture

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Process of Growth in a Dualistic Economy:
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Technological Development in Agriculture

(S.S. Joh1)

This paper is a variant of Lewis [3,4] * and Ranis-Fei's [6,7] dualistic models. It attempts to examine the inter-sectoral transfer of labour and capital between the agricultural and industrial sectors of a labour-surplus economy, under the conditions of population growth and improvements in agricultural production technology. Assumptions underlying the argument are:

- i) A two-sector closed economy comprised of agricultural and industrial sectors.
 - ii) Labour and capital flow freely between the two sectors.**
 - iii) Income distribution problem in the agricultural sector is ignored. No doubt a change in the distribution of incomes in agriculture--share of wages and profits, will change the rate of investment and will shift the agricultural production function.
- At the initial stage, the average wage per worker and per productively employed worker in this analysis are at the lowest level.***
- Any change in this wage level will stimulate investments in

*Citations refer to the listings in the bibliography.

**To the extent the two sectors operate independently, externalities get involved, such as government interventions, price distortions and foreign investments, etc. To the extent the economy opens up, interdependence gets reduced or the effects are lagged. To the extent resources (labour and capital) get physically tied up or do not move due to uncertainties, lack of information or fragmentation of labour and capital markets, the adjustments get chocked up and interactions fade out.

***At the initial stage, average wage per worker is the same as the institutional wage in other dualistic models. But, in the analysis, once the redundant labour from agriculture is removed it varies with the level of total product and population.

agriculture as well as labour and capital adjustments between the two sectors via the increased productivity. It will not, however, effect the direction of the argument in this treatment.*

Section-I of this paper deals with the two-sector growth of wages and employment, average agricultural wage rate per worker and per productively employed worker changing with the level of labour force available and employed in agriculture.** With the labour force remaining constant, the impact of a shift in agricultural production function is also considered.

Section-II extends the argument to the situation of increasing population (labour-force) and interactions of improvements in production technology with the labour redundancy, wage rates and inter-sectoral transfer of labour and capital.

Section-1

In the process of growth, Lewis suggested a turning point, where labour will be distributed between agriculture and industry such that all redundant labour will be employed in industry and the marginal labour will have non-negative productivity in agriculture [3,4]. Figure 1.a and 1.b illustrate the situation. With OP as the total labour force, OP_Q labour (fig.1.b) will be in agriculture and PPQ (fig. 1.a and 1.b) will be in industry. How this situation is reached; whether it is automatic, easy or difficult to reach in the labour-surplus developing economies, is not argued here. It is assumed (ignoring the elements of immobility of labour and investment bottlenecks, etc.) that with zero opportunity cost in agriculture, any

*To some extent Mellor and Lele have tried to deal with the distributional aspect in their analysis of labour supply theory of economic development.[5]

**Wages and production are considered in real terms in this paper.

Agriculture & Industry:
Two-Sector Growth of Wages & Employment

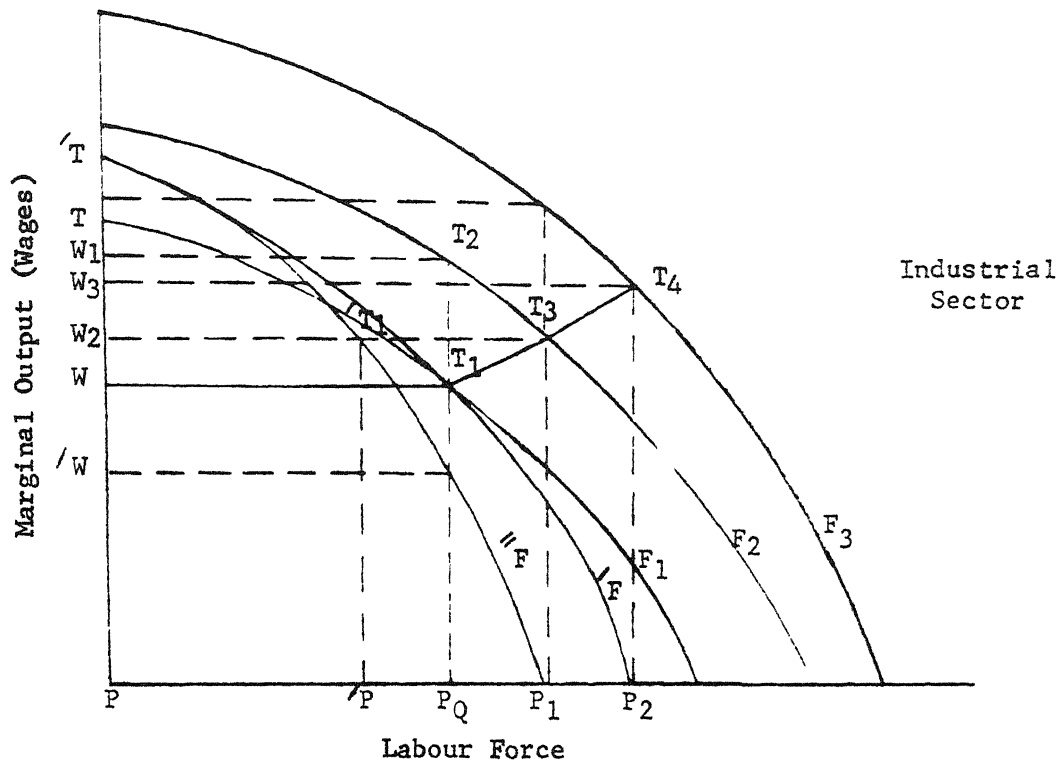


Fig.- 1.a

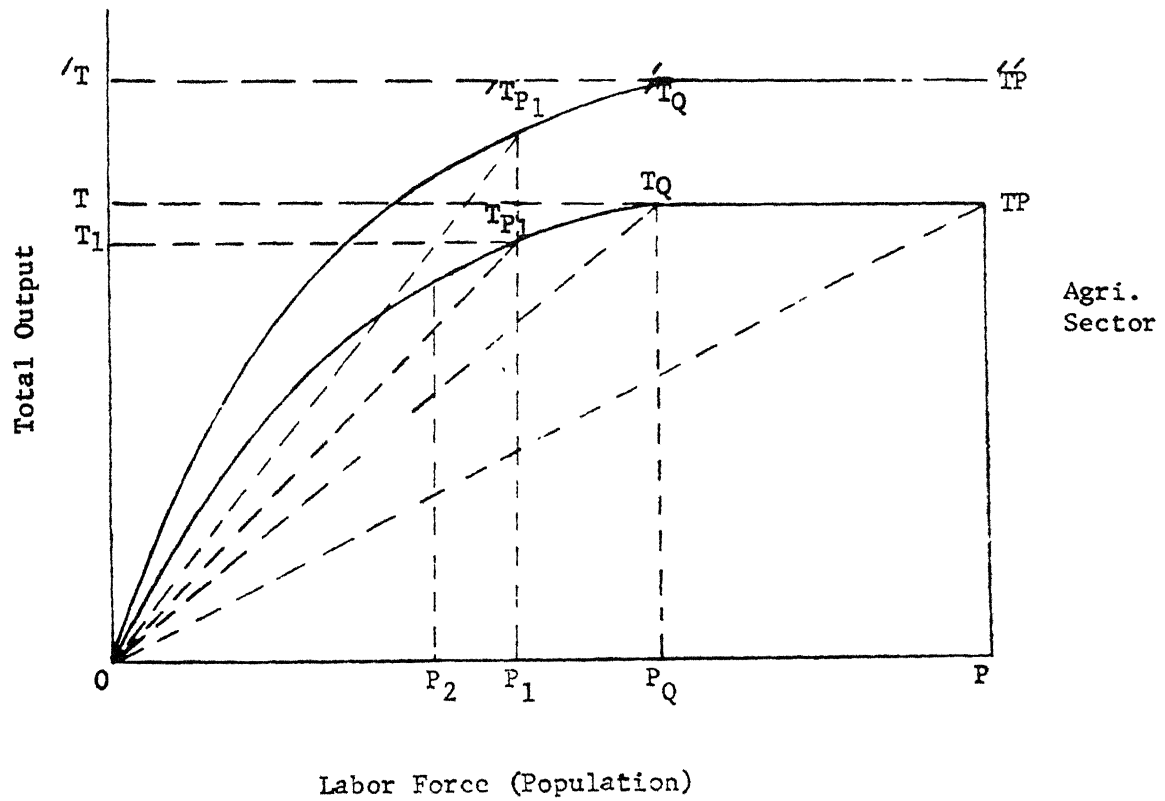


Fig.- 1.b

positive wage outside will make the labour move out so that at least the absolutely redundant labour will get employed at a positive wage rate outside of agriculture. This positive wage will be equal to the institutional wage.

Beyond this point (Lewis' turning point), unlike Ranis-Fei's assumption [8,9], the institutional wage will not hold. As soon as the positive-productivity-labour starts moving out of agriculture, its impact is felt quickly. Very important to note here is that at this point any possibility of reduction in the total product, due to shortage of labour, is reacted to sharply. The agricultural entrepreneur, traditional in outlook whose goal in the traditional agriculture has so far been the maximization of total product, will prefer to pay a higher wage rather than accept any reduction in the total production, howsoever nominal it may be. In the traditional agriculture, the concept of a successful and profitable farming for the farmer is the maximization of his gross product. It is economically justifiable so long as the farmer uses his fixed resources only (mainly the family labour and owned fixed capital). In this case, the maximization of gross product maximizes the returns to his fixed resources. So, it is a perfectly rational behaviour. Through time, the approach becomes so engraved in the thinking process of the farmer that he does not tolerate any marginal reduction in gross product, even if it may mean higher net profit sometimes.*

*This is a point of pivotal importance in the argument. An experience of living, working and thinking with the farmers under the conditions of a traditional agriculture will reveal that the most commonly accepted indicator of a successful farming in the rural communities is not so oftenly assumed sophisticated concepts of 'net earnings' or 'net incomes', but the 'yield per acre' and the 'total production'. It may look naive, yet that is the way it is! Such a behavioural constraint makes a tremendous difference with the inter-sectoral flows of labour and capital and should significantly influence the direction of arguments in the dualistic models of growth.

The institutional wage (the slope of OTP in figure 1.b) at the point where total product starts declining, gives way to the average wage per productive worker (the slope of OT_Q in fig. 1.b). Beyond this point, the industrial wage must be higher than the slope of OT_Q to attract labour from agriculture. On the other hand, due to the increased agricultural wage, the marginal propensity to consume in the agricultural sector will increase reducing the marginal as well as average agricultural surpluses moving out to the industrial sector.* The capital-labour availability ratio, for industry beyond this point will start declining and also terms of trade will start turning against industry. The economy will, therefore, tend to rest around this turning point. This is a crucial point for a labour-surplus and product-short developing economy. Although the marginal productivity of labour in agriculture at this point will be lower than the real industrial wage, the very fact of its becoming positive introduces a behavioral shift on the part of the farm entrepreneur that creates an environment of rising wages and relative capital shortages in the industrial sector.** The forces of a potential decrease in the total production and the higher wages he will have to pay at this turning point, on the other hand, makes the agricultural entrepreneur conscious of emerging troubles in his enterprise and he starts looking around for a product-increasing new technology.*** This leads to an increase in capital investments in agriculture and as a consequence lesser availability of capital for industry.

*The marginal propensity to consume is not assumed to change so long as wage rates remain tied down to the institutional wage in agriculture. As soon as the grip of institutional-wage-forces releases, the MPC also starts increasing.

**Implicitly or explicitly this situation often forces the government distort factor prices through capital subsidization and sharing the costs of training the new industrial labor.

***At this stage, the new technology may not be essentially of labor-substituting nature because of farmers' major concern about total production. The new technology might, thus, have a complementary effect on labour use and its productivity. For further arguments on this point, see Johl [2].

In the first stage, the capital flow to the industrial sector thus decreases and it keeps declining till the agricultural sector shifts to a higher production function and thereby increases the average agricultural surplus (capital for industry). After this happens, the industrial production function will shift upwards to the right (from F_1 to F_2 in dig. 1.a). With a one-shot introduction of technology completed in agriculture, the average wage in agriculture will be the slope of $\acute{O}TP_1$ depending upon how high the production function shifts.* It will be a positive marginal productivity point; not a $'TQ$ redundancy point, which itself can be on, to the left or to the right of the original redundancy point TQ depending upon the nature of the shift in the production function. Here balanced growth path will not remain horizontal (a contrast to the Ranis-Fei position) but will move upwards to the right (from T_1 to T_3 and T_4 in dig. 1.b), approximating the Lewis position but for different reasons as argued in this paper. The balanced-growth-industrial-wage in real terms will be then W_2 (equal to slope $\acute{O}TP_1$) and labour will be employed OP_1 in agriculture and P_1P in the industrial sector. In short, the capital will be allocated to the industry such that F_2 intersects the labor supply curve at T_3 yielding industrial wage $W_2 = \text{slope } \acute{O}TP_1$ and labour is distributed as OP_1 in agriculture and PP_1 in industry.

Another variant of the sequence of events can be that as soon as pressures of high wage are felt in the industrial sector, this sector seeks capital subsidization by the government on grounds of infant industry and/or scale and size economics. This leads to factor-price distortions so

*Although technological improvements rather come in a stream of innovations and there may be lags involved in the sectoral transfer of labour and capital, yet for the purpose of this analysis, introduction of technology is considered in discrete steps and time element is ignored for the sake of convenience. These simplifications are not believed to distort the argument in any way.

commonly found in the developing economies. Capital is subsidized through lower interest rates, direct rebates and subsidies on investments and imports of machinery and equipment at below market exchange rates.* The industrial production technology thus becomes more capital-intensive or labour-substituting; an unexpected and unwanted development in a capital-short economy. At the same level of employment the industrial sector increases profits (returns to capital and management). This leads to an anomolous situation of emphasis on capital-intensive technology in the industrial sector in a capital-short economy, which is bound to create below optimum growth conditions. Or, otherwise the industrial sector can react by increasing the industrial wage (W_2) and reduce the employment of labour (from PP_Q to $\acute{P}P$) holding on to their profit margins ($WT_1T = W_2\acute{T}_1\acute{T}$) through a shift in the production function upwards but to the left as \acute{F} in fig. 1.b. Such a shift in the production function and distribution of incomes between wages and profits can occur through introducing labour-substituting innovations and improvizations, for the same level of output or even a lower level of output. Since the industrial employment in this case will be below the level of labour redundancy in agriculture, unemployed labour will put pressures on the industrial as well as agricultural wage to fall. Ultimately if all redundant labour has to be re-employed vis-a-vis the new industrial production function, the wage must fall below the origional industrial and institutional wages equilibrium (a fall from W to \acute{W}).

*The official exchange rates are lower than the open or black market rates in most of the developing countries. Imports at official exchange rate, are, thus, also a form of capital subsidization.

If this happens*, factor-shares in the industrial-sector-income will go favorable to capital and management, which ultimately will reshape and shift the production function upwards to the right with complementary effects on labour employment and wages.** But, henceforth, the technology will tend to remain relatively more capital intensive. Considered from the view point of resource endowment (capital and labour), the industrial sector will, thus, follow a below optimum growth path, with relatively higher level of wages, and lower employment.

Section-II

Impact of Population Growth

First we consider only the impact of population growth, holding the agricultural production technology constant. Under such a situation, an increase in population (labour force) will lower the average wage per worker. As a consequence, more redundant labour will be available and at a lower wage rate. At the same time, it will also lower the average agricultural surplus moving out with the labour transferred from agriculture to the industrial sector. The industrial sector will get relatively capital starved, but will have lots of low cost labour hovering around. Since industrial production or its expansion needs certain minimum amount of capital per unit of production and it may not be possible to substitute labour for that level of capital (a technological constraint),*** the

*Wages are not normally allowed to fall due to pressures of labour unions and government interventions.

**This ultimate point may, however, turn out to be too far off and initial drop in employment and the level of economic activity might prove to be disastrous for a developing economy plagued with fast increasing population and lack of opportunities in the agricultural sector.

***In the initial stage, the industrial production-technology is visualized to be based on redundant lowest-cost labour freed from agriculture and is, thus, already labour-intensive enough not to have been left with any scope of being made more labour-intensive.

industrial production function will not be able to shift up enough to absorb any additional redundant labour at going industrial wage.* This will develop into a situation of fast increasing urban unemployment, industrial wages remaining higher than the equilibrium level, lower agricultural wages and a virtual stagnation in the economy. In such a situation, government often steps in to provide help in the form of external capital and may subsidize capital investments in industry. In the absence of sufficient internal matching capital resources, however, such factor price distortions do not often work; firstly because of the reasons explained in Section I and also due to the lack of matching growth in demand on account of low wages in the traditional sector (agriculture) which is the consumer of the surplus industrial product.

It becomes, therefore, of crucial importance to generate larger agricultural surpluses so as to transfer capital to the industry at a rate higher than the increases in redundancy brought about by the growth of population. This necessitates the introduction of improved production technology in the traditional sector (agriculture).

Interaction of Improved Production Technology With Population Growth

The impact of an improvement in the production technology in agriculture will be to shift its production function upwards. It may leave the redundancy of labour at the same, higher, or lower level after the counterbalancing effects of the population growth are accounted for. Irrespective of the new level of redundancy, the influence of the new agricultural production technology on the industrial sector will depend on whether the average wage per worker and per productively employed worker moves up or

*An attempt to lower the wage as an alternative is always resisted by labour unions, conventions and even government laws in some cases.

below the original level. If the new average wage is lower than the original one (slopes OF_2 and OR_2 less than slopes OF_1 and OR_1 in fig. 2) the situation of a capital-starved industry operating on a lower production function, an increasing urban unemployment, swelling the ranks of urban traditional-services sector* and conditions of an over-all stagnation of the economy, and even worsening of it, will continue. The agricultural production function in this case might shift from OR_1F_1 to OR_2F_2 with the productively employed labour (including disguisedly unemployed short of redundancy) increasing from OP_Q to OP_1 . Agricultural employment may increase to absorb the entire increase in population, yet the average wage falling below the original level and reduced average agricultural surpluses will force the industrial sector to operate either on a lower production function with all the consequences of reduced industrial wage as well as profits, or otherwise the industry will start exerting pressures on the government to intervene and introduce factor and product price distortions, through subsidies, tax rebates and tariffs, etc.

It is only when technological improvements in agriculture shift agricultural production function upwards enough to out-match the population and redundancy increases that the average wage rate and average agricultural surpluses will increase (slopes OR_1 , OF_2 or OF_3 in fig. 2). When this happens, the transfer of capital (average agricultural surplus) to industry will increase to match with or even out-match the release of labour from agriculture (redundant and even beyond). Only then the industrial sector will be really able to expand capital investments and shift to a higher

*To understand the problem of increasing numbers in the traditional-services sector in South Africa and Latin America, see Thorbecke [8] and Eicher, et.al. [1]

Agricultural Sector: Population Growth, Technological Shift
in Production Function, Average Wage and Redundancy

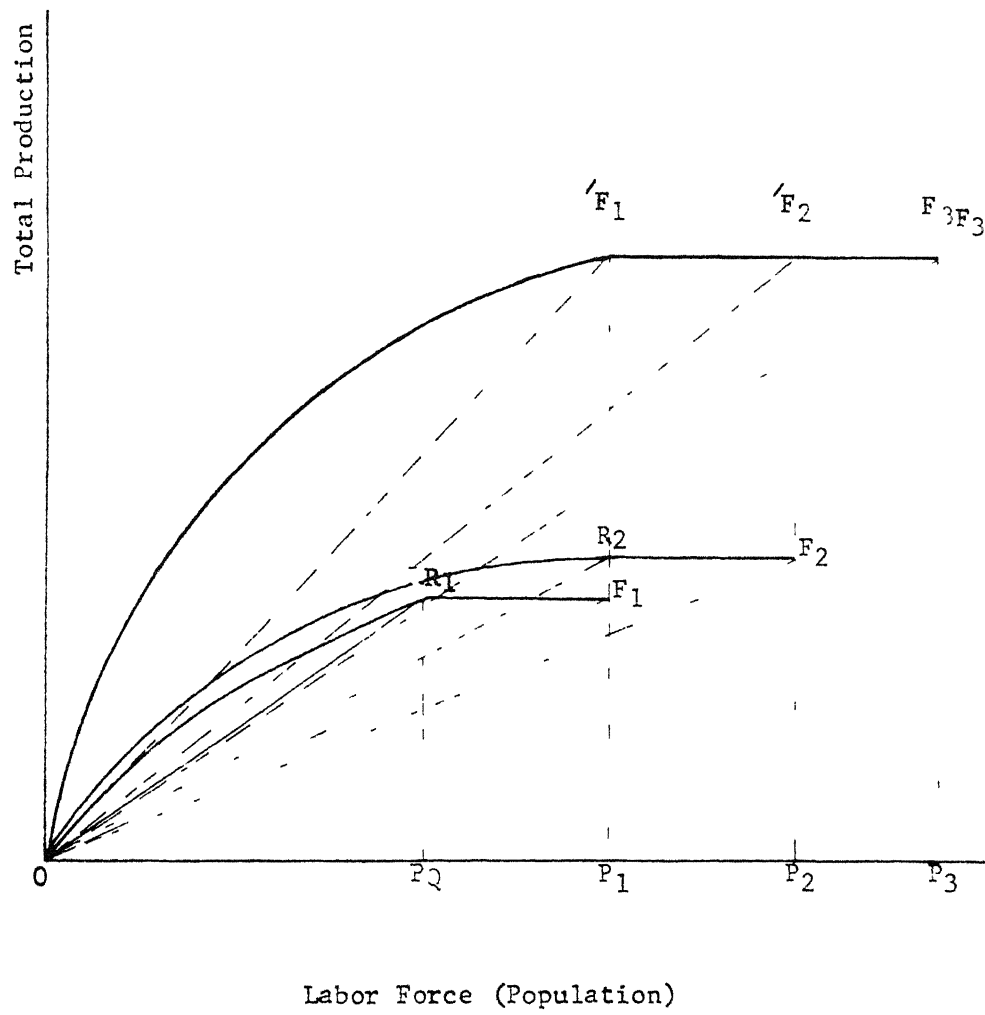


Fig--2

production function without seeking protections and interventions by the government to distort factor and product prices. The argument has an important and interesting implication that irrespective of its influence on level of redundancy of labour force, agricultural production function must shift upwards enough to increase the average wage rate (per worker and per productively employed worker). This can happen only when the upward pull of technological improvements is greater than the downward pull exerted by the horizontal expansion of population. This means that for the purpose of economic growth and increased employment in the economy as a whole, it may not be crucially necessary to bias the agricultural production to be more labour-intensive in response to the population and work-force increase in the agricultural sector. A policy compromising increases in the total agricultural production with the increased employment in the agricultural sector through the introduction of comparatively less efficient labour-intensive technology may not be, therefore, the best and even a rational policy for the developing economies suffering from shortages of agricultural surpluses and redundant or disguisedly unemployed labour force.

Conclusions and Policy Implications

The agricultural sector (traditional sector) is a reservoir of labour and generator of capital resources for the industrial sector (modern sector) of the developing economies. There is no place in the process of economic growth for a showdown between the traditional agricultural sector and the modern industrial sector. A modern industrial sector can be built up only on the basis of surpluses of a modernized dynamic agricultural sector. Policies directed at distorting the factor prices through special low cost capital, tax rebates and subsidies, etc., to favour the industrial sector in order to develop it into a modern sector without a matching

growth in the agricultural sector, run at odds and have a remote chance of achieving the desired goals. Such a set of policies leads to a paradoxical situation of artificially high industrial wages, growing urban unemployment, soaring urban traditional-services sector, growing pressures on government for capital subsidization in industry, low agricultural wages and disguised as well as open unemployment, leading to the conditions developing into an over-all agricultural as well as industrial stagnation. The logic also provides another important insight that irrespective of the level of redundancy of the labour force in agriculture, which may be increasing in future due to the natural growth of population, and irrespective of the production technology being more capital intensive or labour substituting, the agricultural production function must shift up enough to keep the average production (real wage) per worker increasing in order to develop a viable modern (industrial) sector. In the policy structure of the developing countries, explicit emphasis must, therefore, be placed on increasing agricultural production and surpluses. Average production per worker (or in other words, the total production) must not be sacrificed to force a labour-intensive technology in agriculture. Labour-intensive technology in agriculture can be justified only to the extent it does not reduce the rate of growth of average per capita production or total production.

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